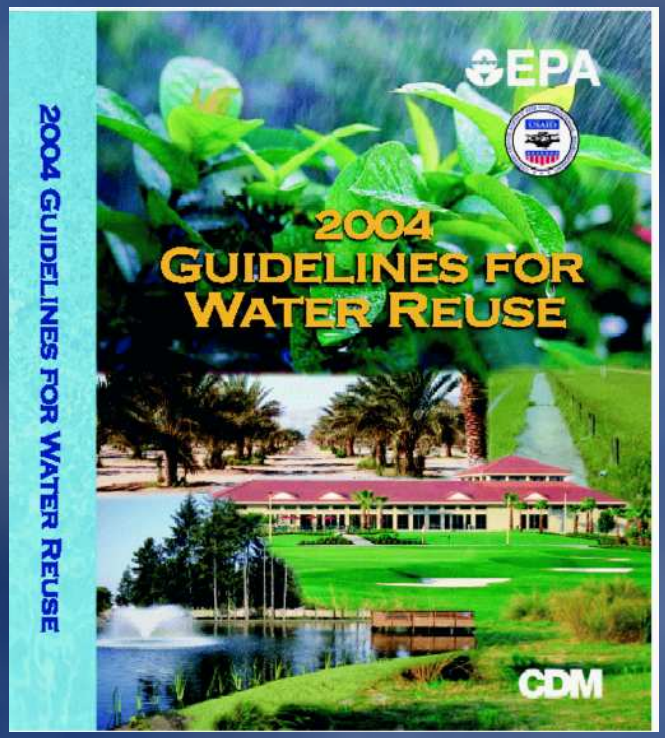
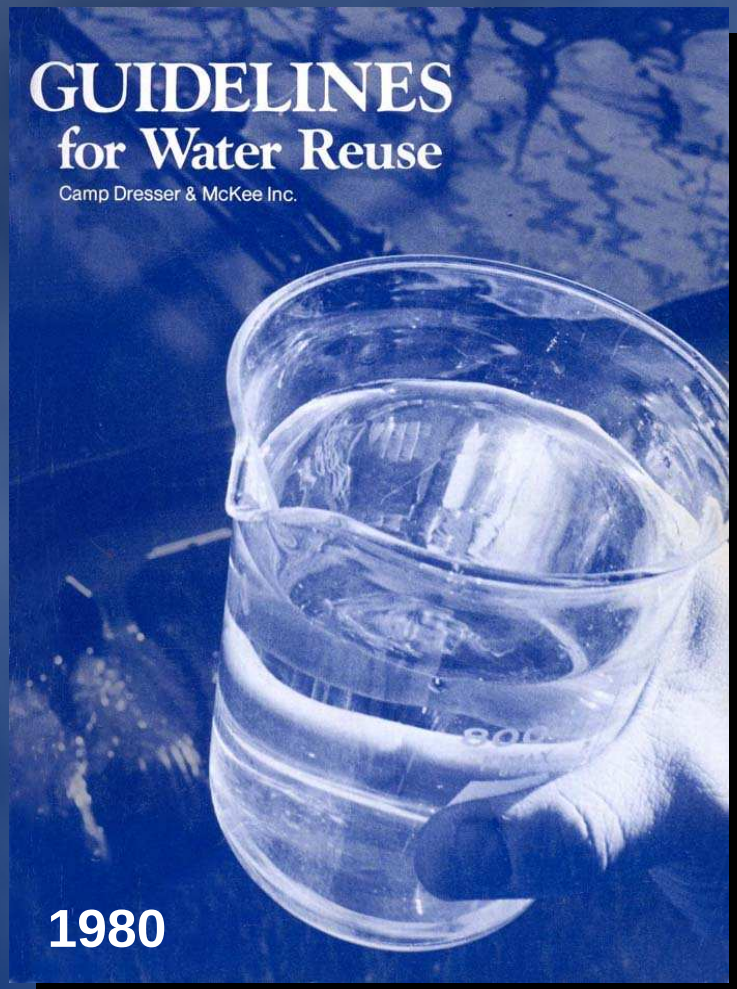


2004 EPA *Guidelines for Water Reuse*

Robert K. Bastian
U.S. EPA, Office of Wastewater Management
Washington, D.C. 20460

1980 Guidelines Objective

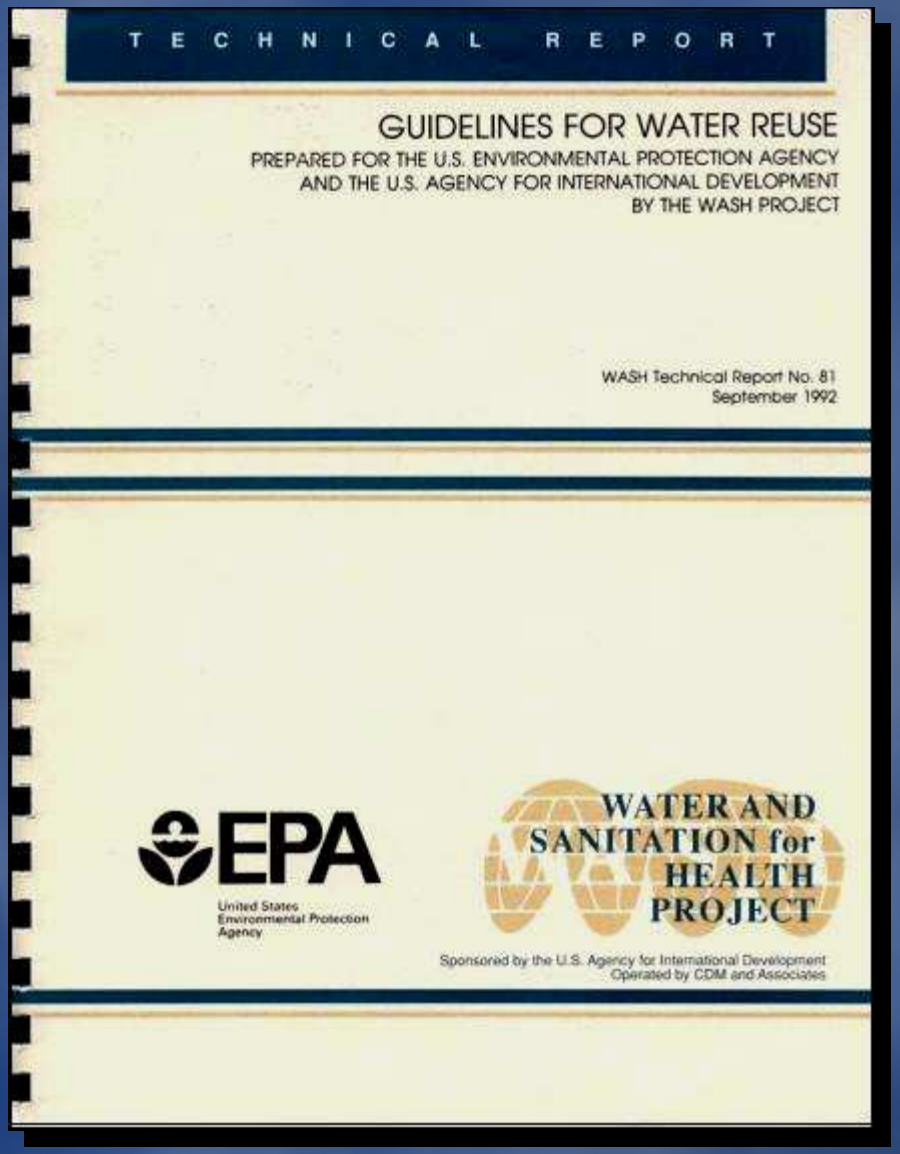


- To Make Water Managers and Resource Planners Aware of the Proven Possibilities of Water Reclamation

History of the Guidelines

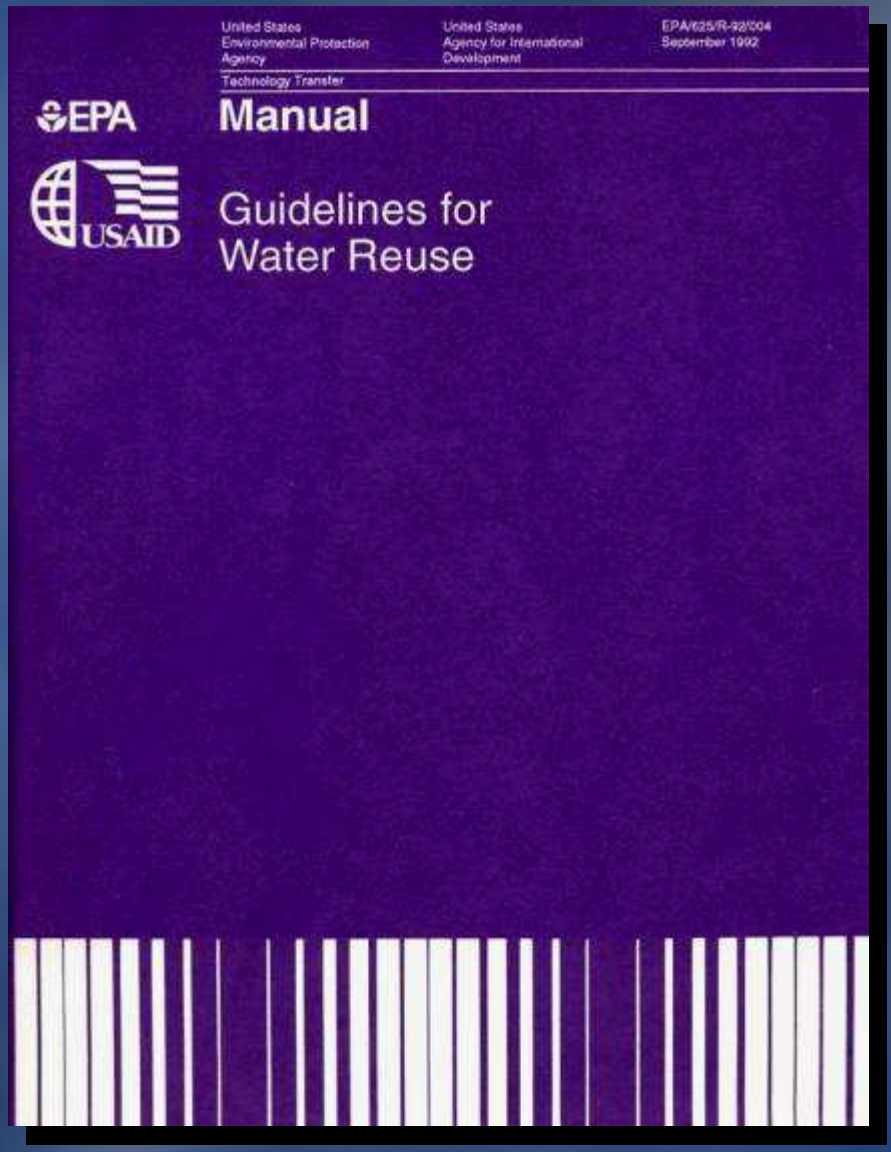
- Initial Guidelines 1980
- Initial Update 1992 (w/recommended guidelines)
- 2004 Update

The Objective of the Guidelines has Remained the Same over the Last 23 Years

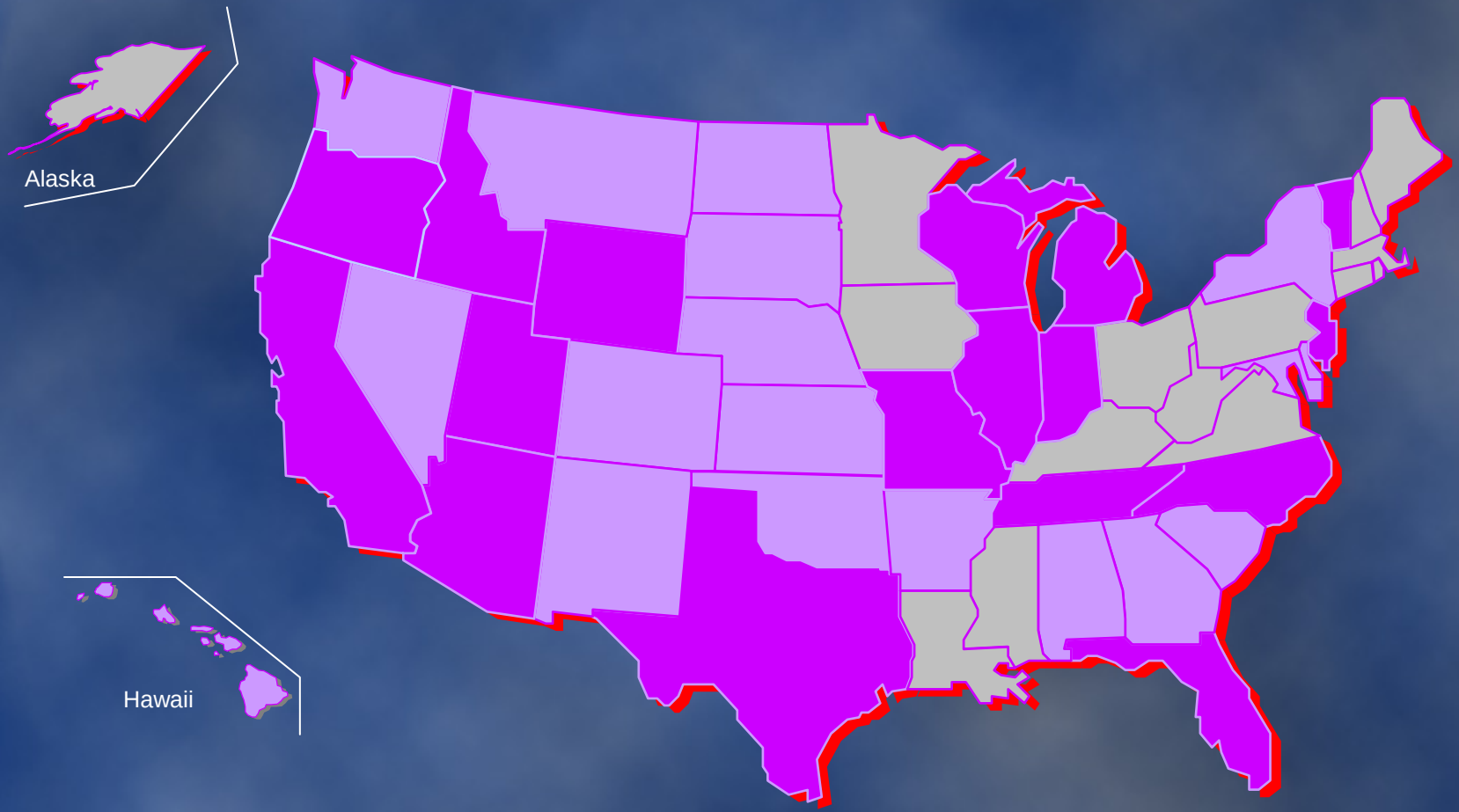

TECHNICAL REPORT
GUIDELINES FOR WATER REUSE
PREPARED FOR THE U.S. ENVIRONMENTAL PROTECTION AGENCY
AND THE U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT
BY THE WASH PROJECT
WASH Technical Report No. 81
September 1992
EPA
United States
Environmental Protection
Agency
WATER AND
SANITATION for
HEALTH
PROJECT
Sponsored by the U.S. Agency for International Development
Operated by CDM and Associates

1992

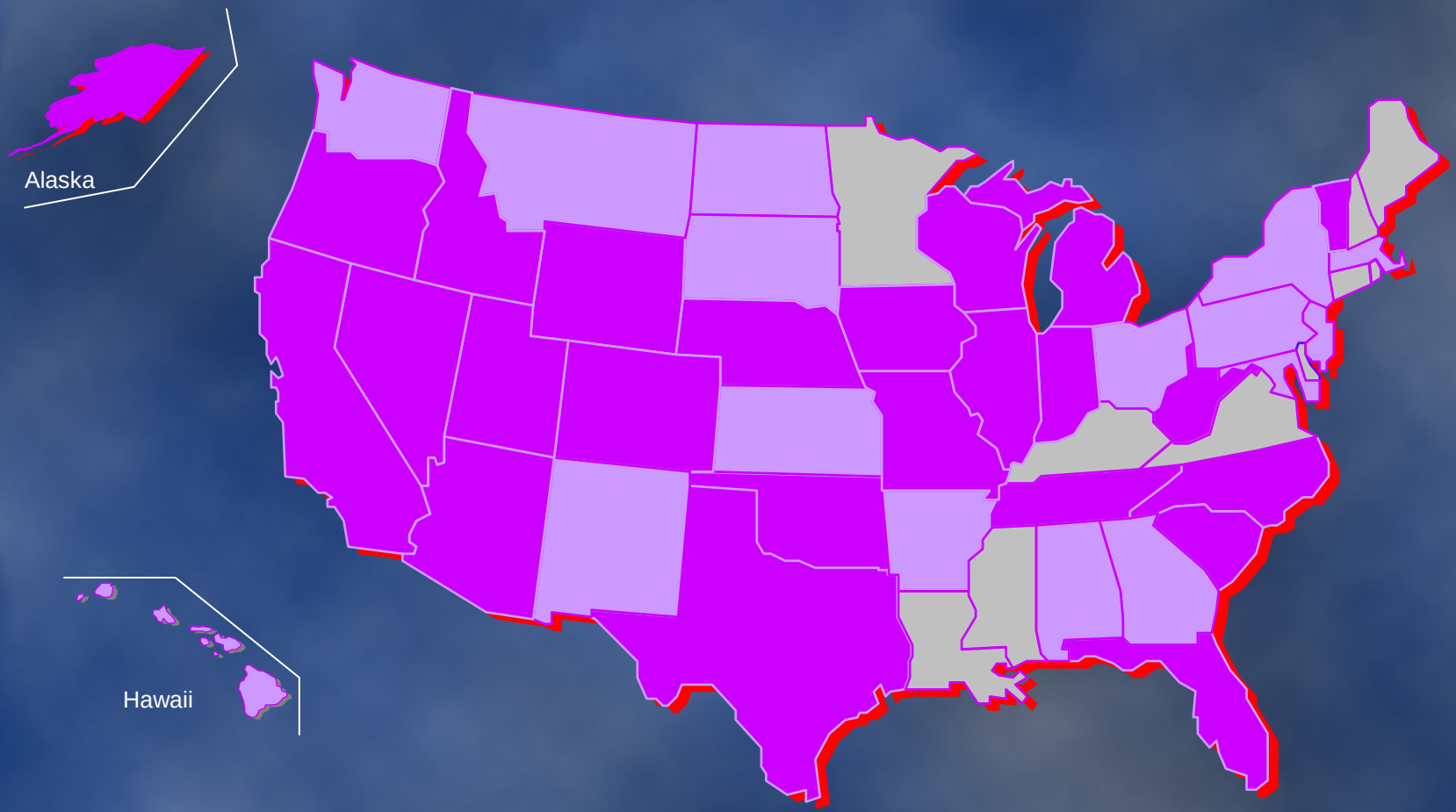
1992


United States
Environmental Protection
Agency
United States
Agency for International
Development
EPA/625/R-92/004
September 1992
Technology Transfer
EPA
USAID
Manual
Guidelines for
Water Reuse

States with Reuse Regulations and Guidelines in 1992



Status in 2003



Summary of State Reuse Regulations and Guidelines

State	Regulations	Guidelines	No Regulations or Guidelines [1]	Change from 1992 Guidelines for Water Reuse [2]	Unrestricted Urban Reuse	Restricted Urban Reuse	Agricultural Reuse Food Crops	Agricultural Reuse Non-Food Crops	Unrestricted Recreational Reuse	Restricted Recreational Reuse	Environmental Reuse	Industrial Reuse	Groundwater Recharge	Indirect Potable Reuse
Alabama		●		N		●		●						
Alaska	●			NR				●						
Arizona	●			U	●	●	●	●		●				
Arkansas		●		N	●	●	●	●						
California [3]	●			U	●	●	●	●	●	●		●	●	●
Colorado	● [4]			GR	●	●	●	●	●	●				
Connecticut			●	N										
Delaware	●			GR	●	●		●						
Florida	●			U	●	●	●	●			●	●	●	●
Georgia		●		U	●	●		●						
Hawaii		●		U	●	●	●	●		●		●	●	●
Idaho	●			N	●	●	●	●						
Illinois	●			U	●	●		●						
Indiana	●			U	●	●	●	●						
Iowa	●			NR		●		●						
Kansas		●		N	●	●	●	●						
Kentucky			●	N										
Louisiana			●	N										
Maine			●	N										
Maryland		●		N		●		●						
Massachusetts		●		NG	●	●		●					●	●
Michigan	●			N			●	●						
Minnesota			●	N										
Mississippi			●	N										
Missouri	●			N		●		●						
Montana	●			GR	●	●	●	●						
Nebraska	●			GR		●		●						
Nevada	●			GR	●	●	●	●	●	●				
New Hampshire			●	N										
New Jersey		●		RG	●	●	●	●				●		
New Mexico		●		N	●	●	●	●						
New York		●		N				●						
North Carolina	●			U	●	●						●		
North Dakota		●		U	●	●		●						
Ohio		●		NG	●	●		●						
Oklahoma	●			GR		●	●	●						
Oregon	●			N	●	●	●	●	●	●		●		
Pennsylvania		●		NG				●						
Rhode Island			●	N										
South Carolina	●			GR	●	●		●						
South Dakota		●		N	●	●		●			●			
Tennessee	●			N	●	●		●						
Texas	●			U	●	●	●	●	●	●		●		
Utah	●			U	●	●	●	●	●	●		●		
Vermont	●			N				●						
Virginia			●	N										
Washington		●		U	●	●	●	●	●	●	●	●	●	●
West Virginia	●			N			●	●						
Wisconsin	●			N				●						
Wyoming	●			U	●	●	●	●						

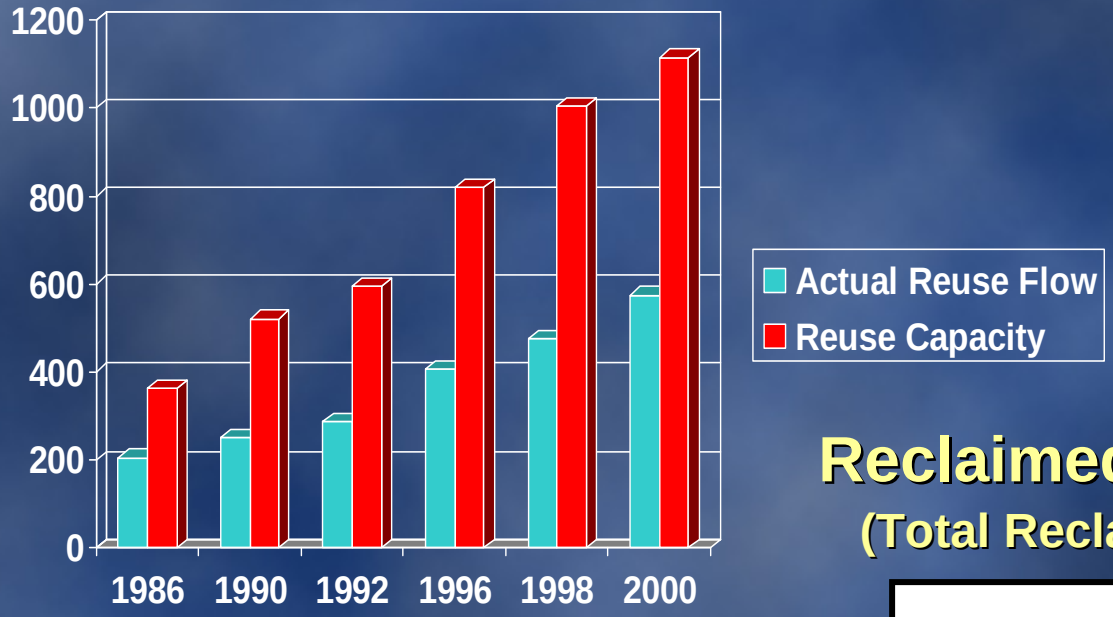
Overview of Current Water Reuse Regulations or Guidelines

- 25 states have adopted regulations
- 16 states have guidelines or design standards
- 9 states have no regulations or guidelines
- Reuse may be permitted on a case-by-case basis

Why Were the Guidelines Updated in 2004?

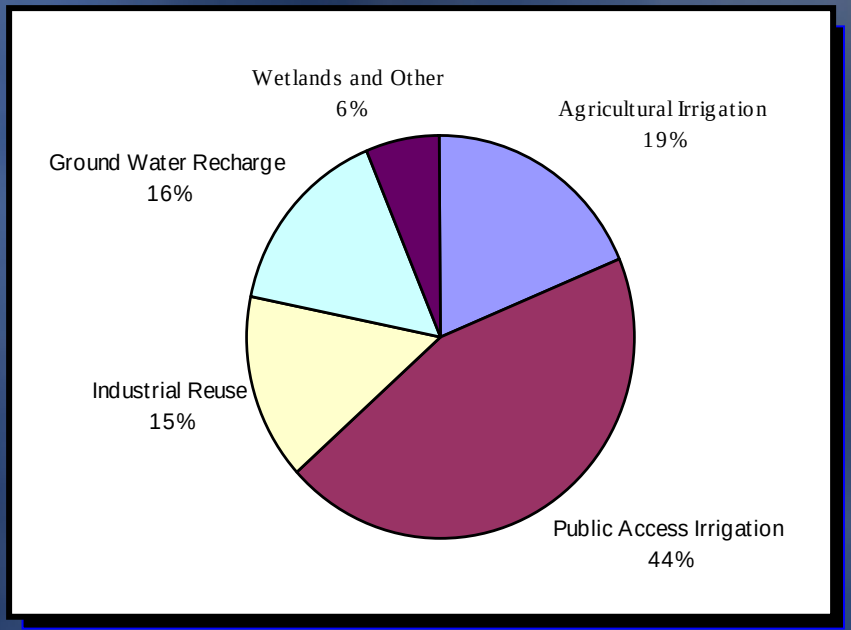
- Emerging pathogens
- Emerging pollutants of concern
- Increasing pressure on water resources
- Extensive new information since early 1990's

Florida's Recent Reuse History

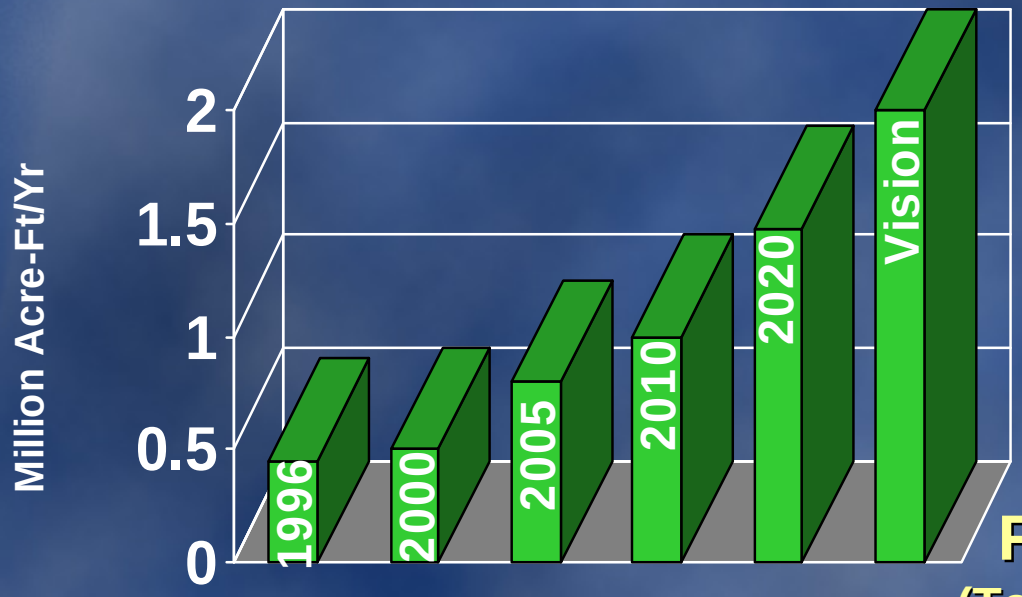


Reclaimed Water Use in Florida

(Total Reclaimed Water Flow = 575mgd)

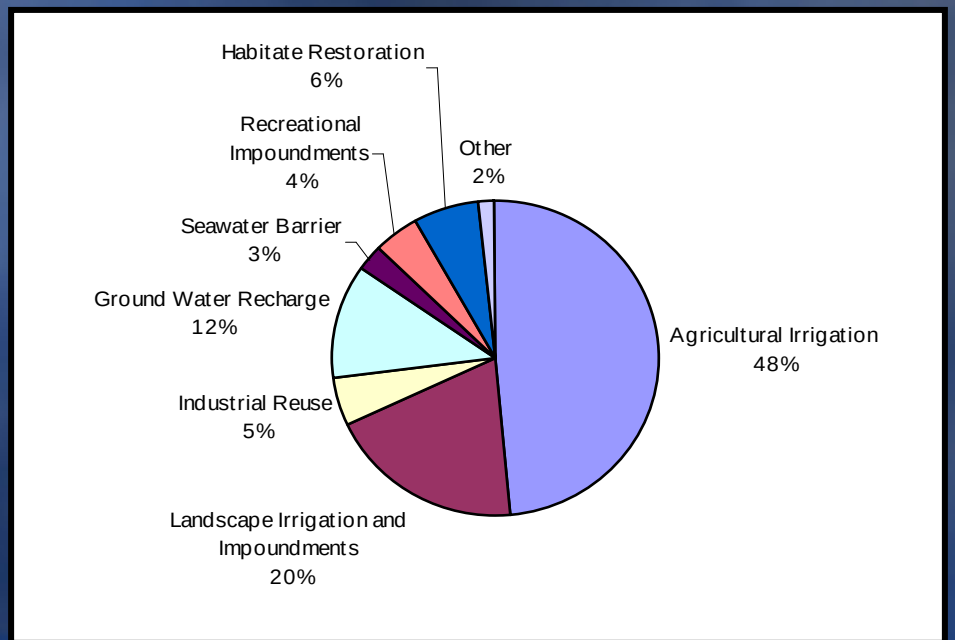


California Water Recycling Potential

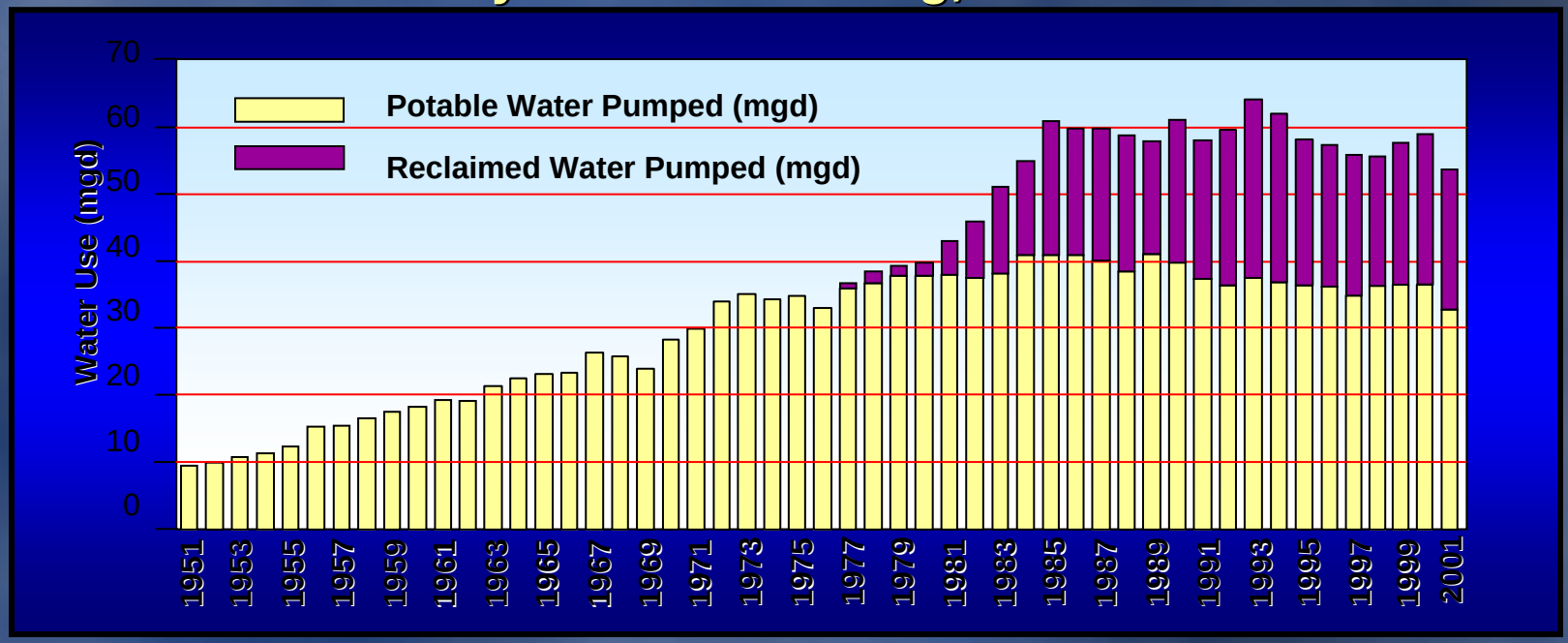


Reclaimed Water Use in CA

(Total Reclaimed Water Flow = 358 mgd)



Potable and Reclaimed Water Usage
City of St. Petersburg, FL



Potable and Reclaimed Water Use
in a North Carolina Residential Development

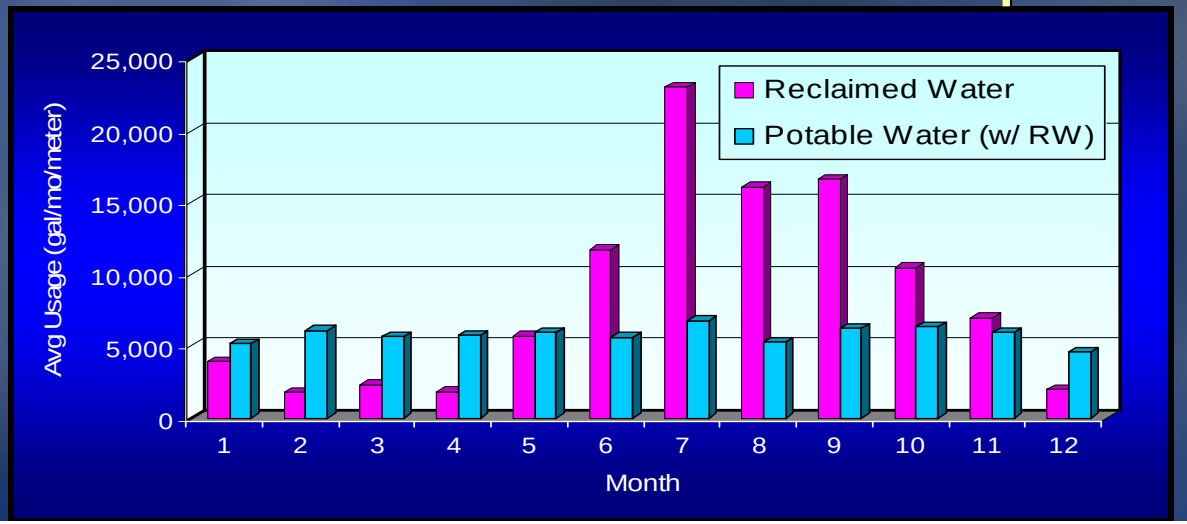
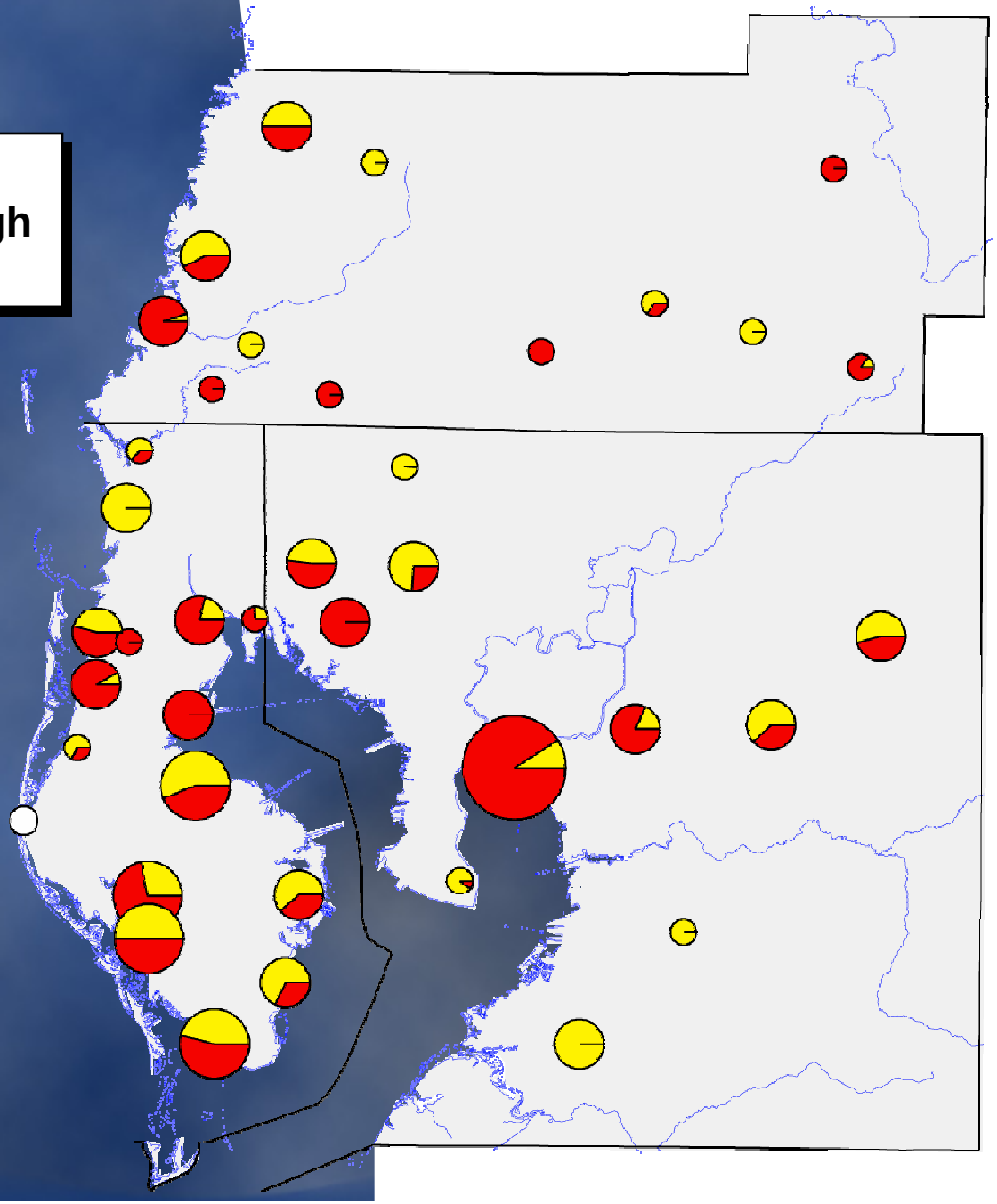


Figure and Statistics Provided By

Southwest Florida Water Management District

Available Reclaimed Water in Pasco, Pinellas and Hillsborough Counties – Dry Year (2000)



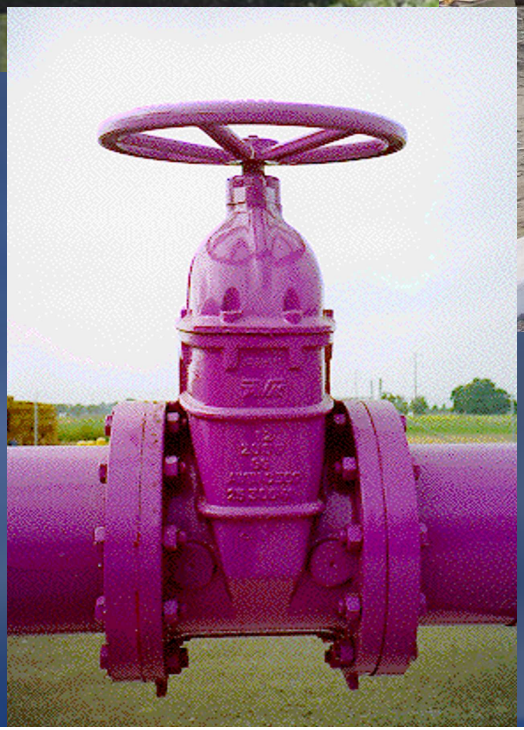
Total WWTP Flow (MGD)

- 0-2
- 2-10
- 10-20
- 20-40
- 40-80

- % RW used in 2000
- % RW unused in 2000


IRRIGATION WITH
RECLAIMED WATER
DO NOT DRINK
AVISO... AGUA RECICLADA
SE PROHIBE BEBER


56
IRRIGATION WATER
NOT FOR DRINKING
AGUA PARA RIEGO
NO PARA TOMAR



Updates

80 New Case Studies

- Design
- Public Participation
- Funding

References

- 360+
- Major Reuse Conferences

Major Changes from 1980 to 1992 Guidelines

- A Major Rewrite (106 to 254 pages)
- Water Resource Driven
- Inventory of State Regulations
- Expanded Case Studies
- Added International Reuse
- Provided Treatment Guidelines

Major Changes from 1992 Guidelines to 2004 Update

- Major Expansion in Length (254 to 478 pages)
- New Technologies & Practices
- Expanded Coverage of Indirect Potable Reuse
- Emerging Pathogen & Chemical Concerns
- Expanded Case Studies
- Updated Inventory of State Regulations
- List of State Contacts & Web Sites
- List of Research Efforts
- Expanded Coverage of Int'l. Reuse

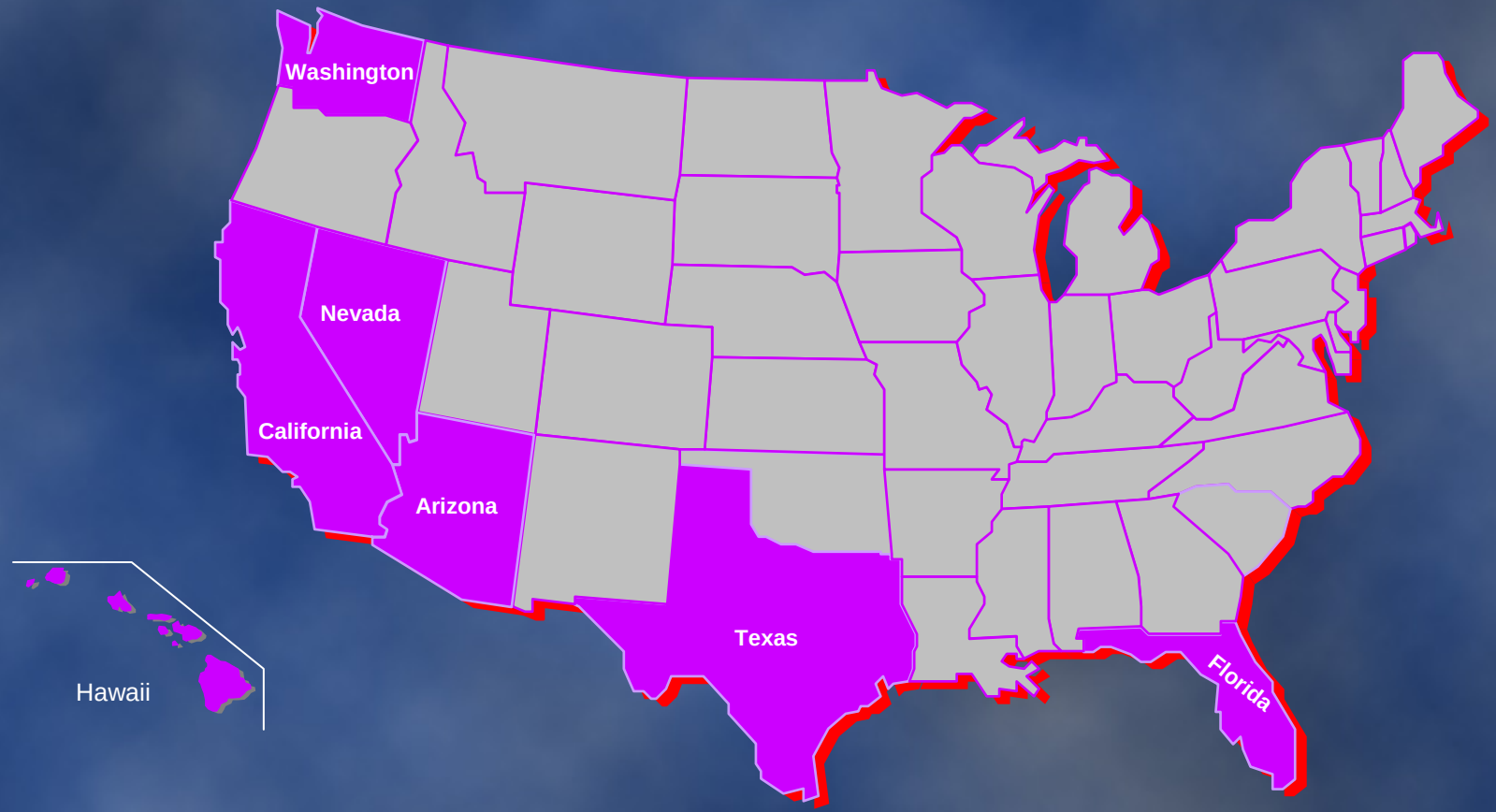
New Sections and Sections with Major Revisions

- Conserving potable water through reuse
- Pathogenic microorganisms and risk
- Treatment requirements
- Groundwater recharge
- Fate of contaminants
- Emerging Contaminants
- Updated Inventory of State Regulations
- Public participation
- Potable reuse issues

Chapters

1. Introduction
2. Types of Reuse Applications
3. Technical Issues in Planning Water Reuse Systems
4. Water Reuse Regulations and Guidelines in the U.S.
5. Legal and Institutional Issues
6. Funding Alternatives for Water Reuse Systems
7. Public Information Programs
8. Water Reuse Outside the U.S.

States Used as Examples for Reuse Regulations



Unrestricted Urban Reuse

	Arizona	California	Florida	Hawaii	Nevada	Texas	Washington
Treatment	Secondary treatment, filtration, and disinfection	Oxidized, coagulated, filtered, and disinfected	Secondary treatment, filtration, and high-level disinfection	Oxidized, filtered, and disinfected	Secondary treatment and disinfection	NS [1]	Oxidized, coagulated, filtered, and disinfected
BOD_6	NS	NS	20 mg/l $CBOD_5$	NS	30 mg/l	5 mg/l	30 mg/l
TSS	NS	NS	5.0 mg/l	NS	NS	NS	30 mg/l
Turbidity	2 NTU (Avg)	2 NTU (Avg)	NS	2 NTU (Max)	NS	3 NTU	2 NTU (Avg)
	5 NTU (Max)	5 NTU (Max)					5 NTU (Max)
Coliform	Fecal	Total	Fecal	Fecal	Fecal	Fecal	Total
	None detectable (Avg)	2.2/100 ml (Avg)	75% of samples below detection	2.2/100 ml (Avg)	2.2/100 ml (Avg)	20/100 ml (Avg)	2.2/100 ml (Avg)
	23/100 ml (Max)	23/100 ml (Max in 30 days)	25/100 ml (Max)	23/100 ml (Max in 30 days)	23/100 ml (Max)	75/100 ml (Max)	23/100 ml (Max)

Restricted Urban Reuse

	Arizona	California	Florida	Hawaii	Nevada	Texas	Washington
Treatment	Secondary treatment and disinfection	Secondary – 23, oxidized, and disinfected	Secondary treatment, filtration, and high-level disinfection	Oxidized and disinfected	Secondary treatment and disinfection	NS [1]	Oxidized and disinfected
BOD_5	NS	NS	20 mg/l $CBOD_5$	NS	30 mg/l	20 mg/l	30 mg/l
TSS	NS	NS	5 mg/l	NS	NS	NS	30 mg/l
Turbidity	NS	NS	NS	2 NTU (Max)	NS	3 NTU	2 NTU (Avg) 5 NTU (Max)
Coliform	Fecal	Total	Fecal	Fecal	Fecal	Fecal	Total
	200/100 ml (Avg)	23/100 ml (Avg)	75% of samples below detection	23/100 ml (Avg)	23/100 ml (Avg)	200/100 ml (Avg)	23/100 ml (Avg)
	800/100 ml (Max)	240/100 ml (Max in 30 days)	25/100 ml (Max)	200/100 ml (Max)	240/100 ml (Max)	800/100 ml (Max)	240/100 ml (Max)

Agricultural Reuse - Food Crops

	Arizona	California	Florida	Hawaii	Nevada	Texas	Washington
Treatment	Secondary treatment, filtration, and disinfection	Oxidized, coagulated, filtered, and disinfected	Secondary treatment, filtration, and high-level disinfection	Oxidized, filtered, and disinfected	Secondary treatment and disinfection	NS (1)	Oxidized, coagulated, filtered, and disinfected
BOD5	NS	NS	20 mg/l $CBOD_5$	NS	30 mg/l	5 mg/l	30 mg/l
TSS	NS	NS	5 mg/l	NS	NS	NS	30 mg/l
Turbidity	2 NTU (Avg)	2 NTU (Avg)	NS	2 NTU (Max)	NS	3 NTU	2 NTU (Avg)
	5 NTU (Max)	5 NTU (Max)					5 NTU (Max)
Coliform	Fecal	Total	Fecal	Fecal	Fecal	Fecal	Total
	None detectable (Avg)	2.2/100 ml (Avg)	75% of samples below detection	2.2/100 ml (Avg)	200/100 ml (Avg)	20/100 ml (Avg)	2.2/100 ml (Avg)
	23/100 ml (Max)	23/100 ml (Max in 30 days)	25/100 ml (Max)	23/100 ml (Max in 30 days)	400/100 ml (Max)	75/100 ml (Max)	23/100 ml (Max)

Agricultural Reuse - Non-Food Crops

	Arizona	California	Florida	Hawaii	Nevada	Texas	Washington
Treatment	Secondary treatment and disinfection	Secondary-23, Oxidized, and disinfected	Secondary treatment, basic disinfection	Oxidized, filtered, and disinfected	Secondary treatment and disinfection	NS [1]	Oxidized and disinfected
BOD_5	NS	NS	20 mg/l $CBOD_5$	NS	30 mg/l	5 mg/l	30 mg/l
TSS	NS	NS	20 mg/l	NS	NS	NS	30 mg/l
Turbidity	NS	NS	NS	2 NTU (Max)	NS	3 NTU	2 NTU (Avg) 5 NTU (Max)
Coliform	Fecal	Total	Fecal	Fecal	Fecal	Fecal	Total
	200/100 ml (Avg)	23/100 ml (Avg)	200/100 ml (Avg)	2.2/100 ml (Avg)	200/100 ml (Avg)	20/100 ml (Avg)	23/100 ml (Avg)
	800/100 ml (Max)	240/100 ml (Max in 30 days)	800/100 ml (Max)	23/100 ml (Max)	400/100 ml (Max)	75/100 ml (Max)	240/100 ml (Max)

Unrestricted Recreational Reuse

	Arizona	California	Florida	Hawaii	Nevada	Texas	Washington
Treatment	NR [1]	Oxidized, coagulated, clarified, filtered, and disinfected	NR	NR	Secondary treatment and disinfection	NS	Oxidized, coagulated, filtered, and disinfected
BOD_5	NR	NS[2]	NR	NR	30 mg/l	5 mg/l	30 mg/l
TSS	NR	NS	NR	NR	NS	NS	30 mg/l
Turbidity	NR	2 NTU (Avg)	NR	NR	NS	3 NTU	2 NTU (Avg)
		5 NTU (Max)					5 NTU (Max)
Coliform	NR	Total	NR	NR	Fecal	Fecal	Fecal
		2.2/100 ml (Avg)			2.2/100 ml (Avg)	20/100 ml (Avg)	2.2/100 ml (Avg)
		23/100 ml (Max in 30 days)			23/100 ml (Max)	75/100 ml (Max)	23/100 ml (Max)

Restricted Recreational Reuse

	Arizona	California	Florida	Hawaii	Nevada	Texas	Washington
Treatment	Secondary treatment, filtration, and disinfection	Secondary-23, oxidized, and disinfected	NR [1]	Oxidized, filtered, and disinfected	Secondary treatment and disinfection	NS	Oxidized and disinfected
BOD_5	NS[2]	NS	NR	NS	30 mg/l	20 mg/l	30 mg/l
TSS	NS	NS	NR	NS	NS	NS	30 mg/l
Turbidity	2 NTU (Avg)	NS	NR	2 NTU (Max)	NS	NS	2 NTU (Avg)
	5 NTU (Max)						5 NTU (Max)
Coliform	Fecal	Total		Fecal	Fecal	Fecal	Total
	None detectable (Avg)	2.2/100 ml (Avg)	NR	2.2/100 ml (Avg)	200/100 ml (Avg)	200/100 ml (Avg)	2.2/100 ml (Avg)
	23/100 ml (Max)	23/100 ml (Max in 30 days)		23/100 ml (Max)	23/100 ml (Max)	800/100 ml (Max)	23/100 ml (Max)

Environmental Reuse - Wetlands

	Arizona	California	Florida[1]	Hawaii	Nevada	Texas	Washington
Treatment	NR [2]	NR	Advanced treatment	NR	NR	NR	Oxidized, coagulated, and disinfected
BOD_5	NR	NR	5 mg/l $CBOD_5$	NR	NR	NR	20 mg/l
TSS	NR	NR	5 mg/l	NR	NR	NR	20 mg/l
Coliform	NR	NR	NS [3]	NR	NR	NR	Fecal 2.2/100 ml (Avg) 23/100 ml (Max)
Total Ammonia	NR	NR	2 mg/l	NR	NR	NR	Not to exceed chronic standards for freshwater
Total Phosphorus	NR	NR	1 mg/l	NR	NR	NR	1 mg/l

Industrial Reuse

	Arizona	California	Florida	Hawaii	Nevada	Texas	Washington
Treatment	NR [2]	Oxidized and disinfected	Secondary treatment and basic disinfection	Oxidized and disinfected	NR	NS	Oxidized and disinfected
BOD_5	NR	NS [3]	20 mg/l	NS	NR	20 mg/l	NS
TSS	NR	NS	20 mg/l	NS	NR	---	NS
Turbidity	NR	NS	NS	NS	NR	3 NTU	NS
Coliform	NR	Total	Fecal	Fecal	NR	Fecal	Total
		23/100 ml (Avg)	200/100 ml (Avg)	23/100 ml (Avg)		200/100 ml (Avg)	23/100 ml (Avg)
		240/100 ml (Max in 30 days)	800/100 ml (Max)	200/100 ml (Max)		800/100 ml (Avg)	240/100 ml (Avg)

Groundwater Recharge

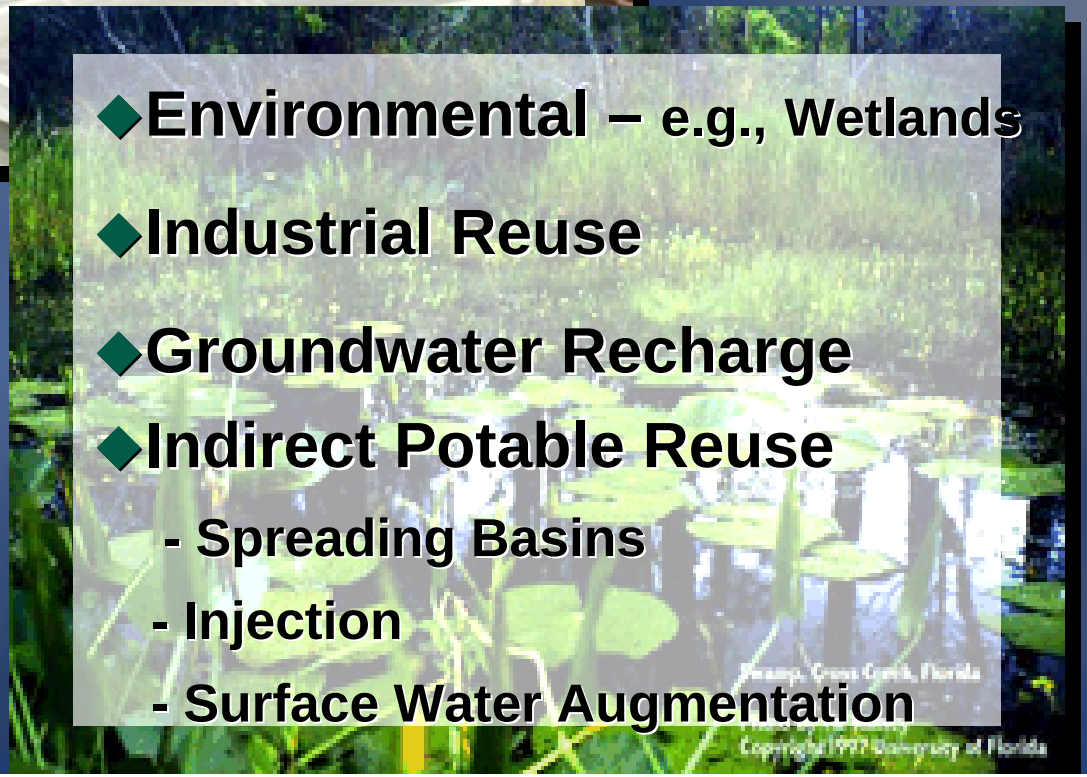
	Arizona	California[2]	Florida	Hawaii	Nevada	Texas	Washington
Treatment	NR [3]	Case-by-case basis	Secondary treatment and basic disinfection	Case-by-case basis	NR	NR	Oxidized, coagulated, filtered, and disinfected
BOD_5	NR		NS[4]		NR	NR	5 mg/l
TSS	NR		10.0 mg/l		NR	NR	5 mg/l
Turbidity	NR		NS		NR	NR	2 NTU (Avg) 5 NTU (Max)
Coliform	NR		NS		NR	NR	Total 2.2/100 ml (Avg) 23/100 ml (Max)
Total Nitrogen	NR		12 mg/l		NR	NR	NS

Indirect Potable Reuse

	Arizona	California[2]	Florida	Hawaii	Nevada	Texas	Washington
Treatment	NR [3]	Case-by-case basis	Advanced treatment, filtration, and high-level disinfection	Case-by-case basis	NR	NR	Oxidized, coagulated, filtered, reverse-osmosis treated, and disinfected
BOD_5	NR		20 mg/l		NR	NR	5 mg/l
TSS	NR		5.0 mg/l		NR	NR	5 mg/l
Turbidity	NR		NS [4]		NR	NR	0.1 NTU (Avg) 0.5 NTU (Max)
Coliform	NR		Total All samples less than detection		NR	NR	Total 1/100 ml (Avg) 5/100 ml (Max)
Total Nitrogen	NR		10 mg/l		NR	NR	10 mg/l
TOC	NR		3 mg/l (Avg) 5 mg/l (Max)		NR	NR	1.0 mg/l
Primary and Secondary Standards	NR		Compliance with most primary and secondary		NR	NR	Compliance with most primary and secondary

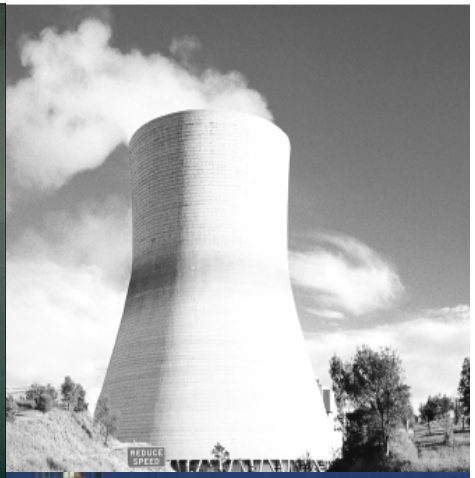
Reuse Categories

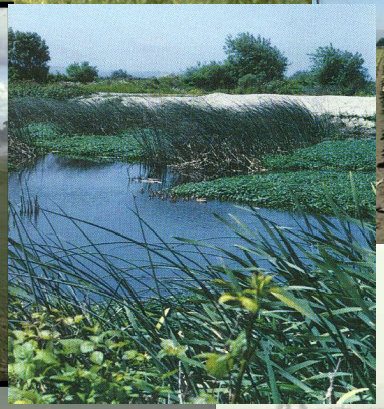
- Unrestricted Urban Reuse
- Restricted Urban Reuse
- Agricultural Reuse for Food Crops
- Agricultural Reuse for Nonfood Crops
- Recreational Impoundments
- Intrusion Barrier



- Environmental – e.g., Wetlands
- Industrial Reuse
- Groundwater Recharge
- Indirect Potable Reuse
  - Spreading Basins
  - Injection
  - Surface Water Augmentation


THIS FIXTURE USES
NON-POTABLE RECLAIMED
WATER-DO NOT DRINK


REDUCE
SPEED

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2004/01/06


Suggested Guidelines for Water Reuse

Types of Reuse	Treatment	Reclaimed Water Quality	Reclaimed Water Monitoring	Setback Distances	Comments
Urban Reuse	■Secondary ■Filtration ■Disinfection	■pH = 6.9 ■<10 mg/L BOD ■< 2 NTU ■No detectable fecal coliform/100 mL ■1 mg/L Cl residual (min.)	■pH – weekly ■BOD – weekly ■Turbidity – continuous ■Coliform – daily ■Cl residual - continuous	■50 ft (15 m) to potable water supply wells	

Types of Reuse	Treatment	Reclaimed Water Quality [2]	Reclaimed Water Monitoring	Setback Distances [3]	Comments
Urban Reuse All types of landscape irrigation, (e.g., golf courses, parks, cemeteries) – also vehicle washing, toilet flushing, use in fire protection systems and commercial air conditioners, and other uses with similar access or exposure to the water	• Secondary [4] • Filtration [5] • Disinfection [6]	• pH = 6-9 • ≤ 10 mg/l BOD [7] • ≤ 2 NTU [8] • No detectable fecal coli/100 ml [9,10] • 1 mg/l Cl_2 residual (minimum) [11]	• pH - weekly • BOD - weekly • Turbidity - continuous • Coliform - daily • Cl_2 residual - continuous	• 50 ft (15 m) to potable water supply wells	• See Table 2-7 for other recommended limits. • At controlled-access irrigation sites where design and operational measures significantly reduce the potential of public contact with reclaimed water, a lower level of treatment, e.g., secondary treatment and disinfection to achieve < 14 fecal coli/100 ml, may be appropriate. • Chemical (coagulant and/or polymer) addition prior to filtration may be necessary to meet water quality recommendations. • The reclaimed water should not contain measurable levels of viable pathogens. [12] • Reclaimed water should be clear and odorless. • A higher chlorine residual and/or a longer contact time may be necessary to assure that viruses and parasites are inactivated or destroyed. • A chlorine residual of 0.5 mg/l or greater in the distribution system is recommended to reduce odors, slime, and bacterial regrowth. • See Section 3.4.3. for recommended treatment reliability.
Restricted Access Area Irrigation Sod farms, silviculture sites, and other areas where public access is prohibited, restricted or infrequent	• Secondary [4] • Disinfection [6]	• pH = 6-9 • ≤ 30 mg/l BOD [7] • ≤ 30 mg/l TSS • ≤ 200 fecal coli/100 ml [9,10,14] • 1 mg/l Cl_2 residual (minimum) [11]	• pH - weekly • BOD - weekly • TSS - daily • Coliform - daily • Cl_2 residual - continuous	• 300 ft (90 m) to potable water supply wells • 100 ft (30 m) to areas accessible to the public (if spray irrigation)	• See Table 2-7 for other recommended limits. • If spray irrigation, TSS less than 30 mg/l may be necessary to avoid clogging of sprinkler heads. • See Section 3.4.3 for recommended treatment reliability.

Types of Reuse	Treatment	Reclaimed Water Quality [2]	Reclaimed Water Monitoring	Setback Distances [3]	Comments
Agricultural Reuse – Food Crops Not Commercially Processed [15] Surface or spray irrigation of any food crop, including crops eaten raw.	• Secondary [4] • Filtration [5] • Disinfection [6]	• pH = 6-9 • ≤ 10 mg/l BOD [7] • ≤ 2 NTU [8] • No detectable fecal coli/100 ml [9,10] • 1 mg/l Cl_2 residual (minimum) [11]	• pH - weekly • BOD - weekly • Turbidity - continuous • Coliform - daily • Cl_2 residual - continuous	• 50 ft (15 m) to potable water supply wells	• See Table 2-7 for other recommended limits. • Chemical (coagulant and/or polymer) addition prior to filtration may be necessary to meet water quality recommendations. • The reclaimed water should not contain measurable levels of viable pathogens. [12] • A higher chlorine residual and/or a longer contact time may be necessary to assure that viruses and parasites are inactivated or destroyed. • High nutrient levels may adversely affect some crops during certain growth stages. • See Section 3.4.3 for recommended treatment reliability.
Agricultural Reuse – Food Crops Commercially Processed [15] Surface Irrigation of Orchards and Vineyards	• Secondary [4] • Disinfection [6]	• pH = 6-9 • ≤ 30 mg/l BOD [7] • ≤ 30 mg/l TSS • < 200 fecal coli/100 ml [9,10,14] • 1 mg/l Cl_2 residual (minimum) [11]	• pH - weekly • BOD - weekly • TSS - daily • Coliform - daily • Cl_2 residual - continuous	• 300 ft (90 m) to potable water supply wells • 100 ft (30 m) to areas accessible to the public (if spray irrigation)	• See Table 2-7 for other recommended limits. • If spray irrigation, TSS less than 30 mg/l may be necessary to avoid clogging of sprinkler heads. • High nutrient levels may adversely affect some crops during certain growth stages. • See Section 3.4.3 for recommended treatment reliability.
Agricultural Reuse – Non-food Crops Pasture for milking animals; fodder, fiber, and seed crops	• Secondary [4] • Disinfection [6]	• pH = 6-9 • ≤ 30 mg/l BOD [7] • ≤ 30 mg/l TSS • < 200 fecal coli/100 ml [9,10,14] • 1 mg/l Cl_2 residual (minimum) [11]	• pH - weekly • BOD - weekly • TSS - daily • Coliform - daily • Cl_2 residual - continuous	• 300 ft (90 m) to potable water supply wells • 100 ft (30 m) to areas accessible to the public (if spray irrigation)	• See Table 2-7 for other recommended limits. • If spray irrigation, TSS less than 30 mg/l may be necessary to avoid clogging of sprinkler heads. • High nutrient levels may adversely affect some crops during certain growth stages. • Milking animals should be prohibited from grazing for 15 days after irrigation ceases. A higher level of disinfection, e.g., to achieve ≤ 14 fecal coli/100 ml, should be provided if this waiting period is not adhered to. • See Section 3.4.3 for recommended treatment reliability.

Types of Reuse	Treatment	Reclaimed Water Quality [2]	Reclaimed Water Monitoring	Setback Distances [3]	Comments
Recreational Impoundments Incidental contact (e.g., fishing and boating) and full body contact with reclaimed water allowed	• Secondary [4] • Filtration [5] • Disinfection [6]	• pH = 6-9 • ≤ 10 mg/l BOD [7] • ≤ 2 NTU [8] • No detectable fecal coli/100 ml [9,10] • 1 mg/l Cl_2 residual (minimum) [11]	• pH - weekly • BOD - weekly • Turbidity - continuous • Coliform - daily • Cl_2 residual - continuous	• 500 ft (150 m) to potable water supply wells (minimum) if bottom not sealed	• Dechlorination may be necessary to protect aquatic species of flora and fauna. • Reclaimed water should be non-irritating to skin and eyes. • Reclaimed water should be clear and odorless. • Nutrient removal may be necessary to avoid algae growth in impoundments. • Chemical (coagulant and/or polymer) addition prior to filtration may be necessary to meet water quality recommendations. • The reclaimed water should not contain measurable levels of viable pathogens. [12] • A higher chlorine residual and/or a longer contact time may be necessary to assure that viruses and parasites are inactivated or destroyed. • Fish caught in impoundments can be consumed. • See Section 3.4.3. for recommended treatment reliability.
Landscape Impoundments Aesthetic impoundment where public contact with reclaimed water is not allowed	• Secondary [4] • Disinfection [6]	• ≤ 30 mg/l BOD [7] • ≤ 30 mg/l TSS • ≤ 200 fecal coli/100 ml [9,10,14] • 1 mg/l Cl_2 residual (minimum) [11]	• pH - weekly • TSS - daily • Coliform - daily • Cl_2 residual - continuous	• 500 ft (150 m) to potable water supply wells (minimum) if bottom not sealed	• Nutrient removal may be necessary to avoid algae growth in impoundments. • Dechlorination may be necessary to protect aquatic species of flora and fauna. • See Section 3.4.3 for recommended treatment reliability.

Types of Reuse	Treatment	Reclaimed Water Quality [2]	Reclaimed Water Monitoring	Setback Distances [3]	Comments
Construction Use Soil compaction, dust control, washing aggregate, making concrete	• Secondary [4] • Disinfection [6]	• ≤ 30 mg/l BOD [7] • ≤ 30 mg/l TSS • ≤ 200 fecal coli/100 ml [9,10,14] • 1 mg/l Cl_2 residual (minimum) [11]	• BOD - weekly • TSS - daily • Coliform - daily • Cl_2 residual - continuous		• Worker contact with reclaimed water should be minimized. • A higher level of disinfection, e.g., to achieve ≤ 14 fecal coli/100 ml, should be provided when frequent work contact with reclaimed water is likely. • See Section 3.4.3 for recommended treatment reliability.
Industrial Reuse Once-through cooling	• Secondary [4] • Disinfection [6]	• pH = 6-9 • ≤ 30 mg/l BOD [7] • ≤ 30 mg/l TSS • ≤ 200 fecal coli/100 ml [9,10,14] • 1 mg/l Cl_2 residual (minimum) [11]	• pH - weekly • BOD - weekly • TSS - daily • Coliform - daily • Cl_2 residual - continuous	• 300 ft (90 m) to areas accessible to the public	• Windblown spray should not reach areas accessible to workers or the public.
Recirculating cooling towers	• Secondary [4] • Disinfection [6] (chemical coagulation and filtration [8] may be needed)	• Variable depends on recirculation ratio (see Section 2.2.1) pH = 6-9 • ≤ 30 mg/l BOD [7] • ≤ 30 mg/l TSS • ≤ 200 fecal coli/100 ml [9,10,14] • 1 mg/l Cl_2 residual (minimum) [11]	• pH - weekly • BOD - weekly • TSS - daily • Coliform - daily • Cl_2 residual - continuous	• 300 ft (90 m) to areas accessible to the public. May be reduced or eliminated if high level of disinfection is provided.	• Windblown spray should not reach areas accessible to workers or the public. • Additional treatment by user is usually provided to prevent scaling, corrosion, biological growths, fouling and foaming. • See Section 3.4.3 for recommended treatment reliability.
Other Industrial Uses	Depends on site specific uses (See Section 2.2.3)				
Environmental Reuse Wetlands, marshes, wildlife habitat, stream augmentation	• Variable • Secondary [4] and disinfection [6] (minimum)	Variable, but not to exceed: • ≤ 30 mg/l BOD [7] • ≤ 30 mg/l TSS • ≤ 200 fecal coli/100 ml [9,10,14]	• BOD - weekly • TSS - daily • Coliform - daily • Cl_2 residual - continuous		• Dechlorination may be necessary to protect aquatic species of flora and fauna. • Possible effects on groundwater should be evaluated. • Receiving water quality requirements may necessitate additional treatment. • The temperature of the reclaimed water should not adversely affect ecosystem. • See Section 3.4.3 for recommended treatment reliability.

Types of Reuse	Treatment	Reclaimed Water Quality [2]	Reclaimed Water Monitoring	Setback Distances [3]	Comments
Groundwater Recharge By spreading or injection into aquifers not used for public water supply	• Site-specific and use dependent • Primary (minimum) for spreading • Secondary [4] (minimum) for injection	• Site-specific and use dependent	• Depends on treatment and use	• Site-specific	• Facility should be designed to ensure that no reclaimed water reaches potable water supply aquifers • See Section 2.5 for more information. • For spreading projects, secondary treatment may be needed to prevent clogging. • For injection projects, filtration and disinfection may be needed to prevent clogging. • See Section 8.4.3 for recommended treatment reliability.
Indirect Potable Reuse Groundwater recharge by spreading into potable aquifers	• Secondary [4] • Disinfection [6] • May also need filtration [5] and/or advanced wastewater treatment [7a]	• Secondary [4] • Disinfection [6] • Meet drinking water standards after percolation through vadose zone	Includes, but not limited to, the following: • pH - daily • Coliform - daily • Cl_2 residual - continuous • Drinking water standards - quarterly • Other [17] - depends on constituent • BOD - weekly • Turbidity - continuous	• 500 ft (150 m) to extraction wells. May vary depending on treatment provided and site-specific conditions.	• The depth to groundwater (i.e., thickness to the vadose zone) should be at least 6 feet (2 m) at the maximum groundwater mounding point. • The reclaimed water should be retained underground for at least 6 months prior to withdrawal. • Recommended treatment is site-specific and depends on factors such as type of soil, percolation rate, thickness of vadose zone, native groundwater quality, and dilution. • Monitoring wells are necessary to detect the influence of the recharge operation on the groundwater. • See Sections 2.5 and 2.6 for more information. • The reclaimed water should not contain measurable levels of viable pathogens after percolation through the vadose zone. [1a] • See Section 8.4.3 for recommended treatment reliability.

Types of Reuse	Treatment	Reclaimed Water Quality [2]	Reclaimed Water Monitoring	Setback Distances [3]	Comments
Indirect Potable Reuse Groundwater recharge by injection into potable aquifers	• Secondary [4] • Filtration [5] • Disinfection [6] • Advanced wastewater treatment [7a]	Includes, but not limited to, the following: • pH = 6.5 - 8.5 • ≤ 2 NTU 8 • No detectable total coli/100 ml [9,10] • 1 mg/l Cl2 residual (minimum) [11] • ≤ 3 mg/l TOC • ≤ 0.2 mg/l TOX • Meet drinking water standards	Includes, but not limited to, the following: • pH - daily • Turbidity - continuous • Total coliform - daily • Cl_2 residual - continuous • Drinking water standards - quarterly • Other [17] - depends on constituent	• 2000 ft (600 m) to extraction wells. May vary depending on site-specific conditions.	• The reclaimed water should be retained underground for at least 9 months prior to withdrawal. • Monitoring wells are necessary to detect the influence of the recharge operation on the groundwater. • Recommended quality limits should be met a the point of injection. • The reclaimed water should not contain measurable levels of viable pathogens after percolation through the vadose zone. [12] • See Sections 2.5 and 2.6 for more information. • A higher chlorine residual and/or a longer contact time may be necessary to assure virus and protozoa inactivation. • See Section 8.4.3 for recommended treatment reliability.
Indirect Potable Reuse Augmentation of surface supplies	• Secondary [4] • Filtration [5] • Disinfection [6] • Advanced wastewater treatment [7a]	Includes, but not limited to, the following: • pH = 6.5 - 8.5 • ≤ 2 NTU [8] • No detectable total coli/100 ml [9,10] • 1 mg/l Cl2 residual (minimum) [11] • ≤ 3 mg/l TOC • Meet drinking water standards	Includes, but not limited to, the following: • pH - daily • Turbidity - continuous • Total coliform - daily • Cl_2 residual - continuous • Drinking water standards - quarterly • Other [17] - depends on constituent	• Site-specific	• Recommended level of treatment is site-specific and depends on factors such as receiving water quality, time and distance to point of withdrawal, dilution and subsequent treatment prior to distribution for potable uses. • The reclaimed water should not contain measurable levels of viable pathogens. [12] • See Sections 2.6 for more information. • A higher chlorine residual and/or a longer contact time may be necessary to assure virus and protozoa inactivation. • See Section 8.4.3 for recommended treatment reliability.

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